The value of the kind, amount, and direction of the clouds to the forecaster on the Pacific coast can not be overestimated. Many times the approach of a storm from the ocean is indicated by the cloud formation several hours before the pressure begins to fall or the winds change in direction and increase in force. Some of the best forecasting that I have ever seen was largely based upon the character and movement of the clouds.

In the forecasts issued from this office for the benefit of the raisin growers when drying their crop in the late summer and early fall, the value of cloud formation is pre-eminent. The conditions to be guarded against are those of unsettled weather, when scattered showers occur in the mountains and foothills and extend down into the valley. There are several types of maps which indicate these conditions, but they are not likely to produce rain unless preceded or accompanied by the rapid formation of a cumulus cap, first appearing on the eastern slope of the Sierra and later extending over the range to the San Joaquin Valley side.—*G. H. Willson, District Forecaster.*

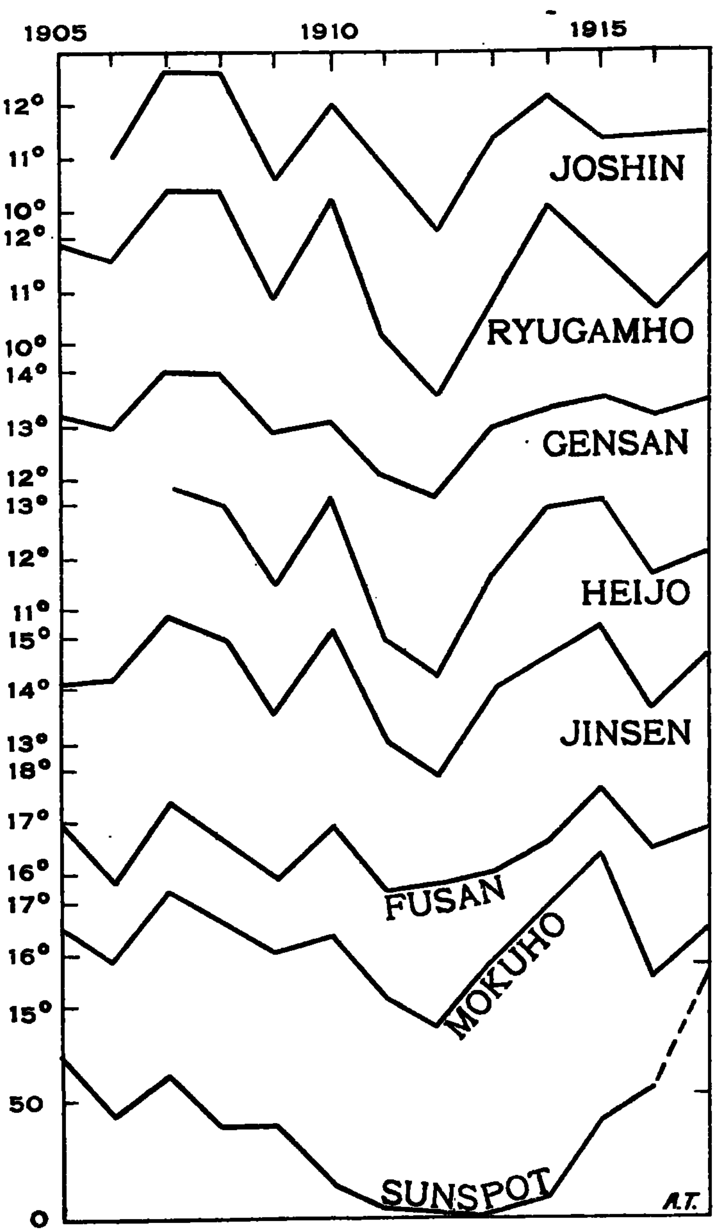

FIG. 1.—Sun-spot numbers, and October temperatures in Chosen.

SOME CORRELATIONS BETWEEN SOLAR ACTIVITY AND THE CLIMATE OF THE FAR EAST.[1]

By R. SEKIGUCHI.

1. *Solar activity and October temperatures of some parts of Chosen (Korea).*—In this report we intend to show the existence of correlations between annual sun-spot numbers and October temperatures of various parts of Chosen. A glance at figure 1 shows undeniable similarities between the general run of the curves representing variations of temperature and the curve of annual sun-spot numbers, though there are many dissimilarities if they are compared part by part. The correlation coefficients have been calculated with the following results:

		Probable error.
Ryugamho (Yongampo)	+0.39	±0.158
Gensan (Wonsan)	+0.58	±0.124
Jinsen (Chemulpo)	+0.39	±0.158
Fusan	+0.48	±0.143
Mokuho (Moppo)	+0.44	±0.150

Similar relations seem to exist throughout the wide area including not only the whole of Chosen but also the northern part of China and the eastern part of Siberia. (See fig. 2.) For instance, the correlation coefficient for Irkutsk (1886–1904) is +0.41±0.132, and that for Tsingtau (1898–1915, except 1914) +0.43±0.123.

In Chosen and Manchuria the month of October is one of the quietest seasons of the year; hence the mean temperature of that month in these regions may be considered to follow faithfully the general distribution of barometric pressure in the Far East, without being greatly disturbed by passing cyclones, etc., as is generally the case in the other seasons and in most parts of Japan proper. Although it may be somewhat premature to draw conclusions from the results that have been found from the observations of such a short period, we have grounds for assuming that they have the following significance: *There is a marked difference between the progress of the development of the Siberian* HIGH *in the period of sun-spot maximum and in the period of sun-spot minimum.* More definite conclusions will be obtained if correlation coefficients over more extended areas be examined. The necessary computations are now going on, and the results will be reported later.

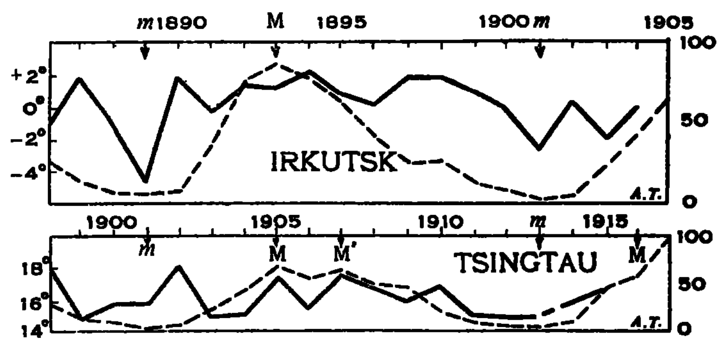

FIG. 2.—Sun-spot numbers, and October temperatures.

(Broken line=relative annual sun-spot numbers, has been supplied by the editor.)

2. *Solar activity and rainfall.*—Some statistical researches have been made to see if there be any correlation between the annual rainfall of Seoul, Chosen, and the annual sun-spot numbers. The rainfall data for the period before 1907 were taken from the table compiled by the late Dr. Y. Wada from the records of the Royal

[1] Condensed from abstract in Jour. Met'l Soc. Japan, Tokyo, July, 1918, 37:33–42.

Court of Korea,[2] and for the remaining years from the Annual Reports of the Meteorological Observatory of the Government General of Chosen. The results are shown in Table 1, which gives the frequency of each class of rainfall for each class of sun-spot numbers. The following peculiarities may be noticed:

(*a*) For annual sun-spot numbers less than 20 the frequency of each rainfall class maintains its normal proportion.[3]

(*b*) For annual sun-spot numbers 20 to 40, the frequency of the rainfall class 1,000–1,200 mm. far exceeds the natural proportion (24 per cent), while those of the remaining classes generally are below their normal proportions.

(*c*) For annual sun-spot numbers 40 to 80, frequency of the next superior and the next inferior class are fairly great, and both exceed the normal proportions (19 and 13 per cent, respectively); while the frequency of the class 1,000–1,200 mm. is less than the normal proportion, and far less than that for sun-spot numbers 20 to 40.

(*d*) When the annual sun-spot numbers exceed 80, the frequencies of two of the three above-named rainfall classes become less than they are in the case of (*c*), while those of the next inferior and the next superior classes both become greater.

In short, in years with excessive sun-spot numbers, the tendency is for the occurrence of either abnormally excessive or abnormally deficient annual rainfalls.

The above results also show that the variability of the annual rainfall at Seoul is least when the annual sun-spot numbers lie between 20 and 40, and becomes greater and greater as the sun-spot numbers increase. In this respect the above results may be worthy of special attention, as O. Meisner has already pointed out a similar relation for Berlin rainfall, and such relations would be expected if the North Pacific and the North Atlantic centers of action are assumed to be more intense in the period of sun-spot maximum than in the period of sun-spot minimum.

We have many reasons for supposing that sun-spot influences upon the climates of the temperate zones tend to lag behind the master phenomena by some years. That is to say, the full climatic effect of variations in the sun would show itself only after some years have elapsed. The amount of such time lag may be different for different regions and for different climatic elements. I have therefore examined by successive trials to see if the annual rainfall of Seoul may not be intimately correlated to the sun-spot number of some one of the preceding 5 years. It has been found that if in any year the sun-spot number be exceedingly great, the annual rainfall three years later tends to be excessive, as will be seen from Table 2.

Furthermore, if the annual rainfalls of Table 2 be divided into two classes, one including all above 900 mm. and the other all below that amount, then out of 24 cases of exceptional solar activity (annual sun-spot number 80 or more), we have only a single case of deficient annual rainfall, while out of 119 cases of lesser sun-spot numbers we have 33 cases (28 per cent) of deficient annual rainfalls. Though this result is too remarkable to be regarded as a mere chance, I will abstain from drawing any conclusion from it.

[2] The period covered by this record is not stated, but the number of relative annual sun-spot numbers equaling or exceeding 80 indicates that it extends back at least to include the year 1769.—EDITOR.

[3] Note that there is a slight tendency for above-the-normal frequencies of both extreme deficiency and extreme excess of rainfall, as is also found to be the case from the data in Table 3.—EDITOR.

I have also searched for sun-spot influences upon the rainfall of Kagoshima, Miyazaki, Oita, Nagasaki, Shimonoseki, Idsugahara, and Hiroshima, in the western part of Japan proper, for the period 1886 to 1915. For this purpose the annual rainfalls at these stations in each year, expressed as percentages of the respective normal values, have been combined into a mean value, and the deviations of this mean from 100 per cent have been computed.

In Table 3 the first column gives these deviations arranged according to the order of magnitude; the second column gives the years in which the respective deviations have occurred; and the third column, the number of years counted forward (+) or backward (−) from the nearest sun-spot maximum (M) or minimum (*m*). These results are summarized in Table 4, which shows that both the abnormally excessive and the abnormally deficient annual rainfalls tend to occur near the period of sun-spot maximum or minimum.

3. *Solar activity and cyclones.*—Statistics show that the formation of typhoons is most frequent toward the middle of September. But this is only the average state of things; in fact, the season of maximum typhoon frequency comes in some years considerably earlier and in some years considerably later than this. For instance, in 1899 typhoon formations were most frequent toward the end of August, while in 1909 the maximum frequency was toward the beginning of October. Though it is difficult to point out exactly by what causes such abnormalities are brought about, it can not be doubted that they depend to some extent on the intensity and the position of the North Pacific center of action in the late summer. Therefore, if there be any correlation between the varying solar activity and either the intensity or the position of the North Pacific center of action in the late summer, then we might expect such solar activities to be accompanied by abnormalities in the time of the maximum typhoon activity.

With this expectation in mind, Table 5 has been prepared. The data were taken partly from the Annual Report of the Central Meteorological Observatory of Japan (the barometric depressions) prepared by Dr. T. Okada, to which, through his generosity, I had the liberty to refer. To determine the period of the maximum typhoon frequency, I have proceeded as follows: Subdividing each month into three decades, the number of typhoons in each decade was counted. The arithmetical mean of the typhoon numbers of any three successive decades was adopted as representing the typhoon frequency of the middle decade of the three. From the thus determined typhoon frequencies of all decades of each year the maximum value was taken out. The results are shown in Table 5. The second column gives the maximum value of typhoon frequencies and the third column shows in what decade it occurred. The values in the fourth column were obtained from those in the preceding column by smoothing by the formula,

$$(V_n) = \frac{V_{n-1} + 2V_n + V_{n+1}}{4}$$

These values are plotted in figure 3, from which it can be seen that there is an intimate relation between the solar activity and the time of the maximum frequency of typhoon, though it is not so simple as I had at first expected it to be.

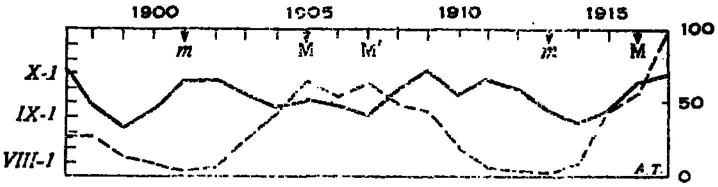

FIG. 3.—Sun-spot numbers and epochs of annual maximum typhoon frequency.

(Broken line=relative annual sun-spot numbers, has been supplied by the editor.)

As for Yang-tze-kiang cyclones, Table 6 is added to point out that there is a general tendency for the annual frequency of cyclones to decrease as the period of sunspot minimum is approached.

TABLE 1.—*Relation between the annual rainfall of Seoul and relative annual sun-spot numbers.*

Annual rainfall.	Relative annual sun-spot numbers.									
	0–20		20–40		40–80		80<		Total.	
	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.
mm.										
<600	2	5	0	0	0	0	0	0	2	1
600–800	8	17	4	14	6	14	5	20	23	16
800–1000	9	19	4	14	9	20	6	24	28	19
1000–1200	11	24	10	34	9	20	4	16	34	24
1200–1400	3	7	4	14	9	20	2	8	18	13
1400–1600	6	14	3	10	4	9	4	16	17	12
1600–1800	3	7	2	7	4	9	1	4	10	7
1800<	4	10	2	7	3	7	3	12	12	8
Total.	46	......	29	......	44	......	25	......	144	......

TABLE 2.—*Relation between relative annual sun-spot numbers and the annual rainfall of Seoul the third year after.*

Rainfall third year after.	Relative annual sun-spot numbers.									
	0–20		20–40		40–80		80<		Total.	
	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.	Frequency.	Per cent.
mm.										
<600	0	0	1	4	1	2	0	0	2	1
600–1000	16	35	12	46	17	36	5	21	50	35
1000–1400	18	41	8	31	18	38	11	46	55	38
1400–1800	7	15	4	16	10	21	7	29	28	20
1800<	5	10	1	4	1	2	1	4	8	6
Total.	46	......	26	......	47	......	24	......	143	......

TABLE 3.—*Deviation of annual rainfall in western Japan from normal, in relation to the epoch of maxima and minima of annual sun-spot numbers.*

Deviation of rainfall.	Year.	Number of years from sun-spot maximum or minimum.		Deviation of rainfall.	Year.	Number of years from sun spot maximum or minimum.	
+35	1905	M	0	−9	1897	M	+4
−23	1904	M	−1	+8	1906	M	+1
−22	1894	M	+1	+8	1912	m	−1
−20	1913	m	0	+8	1914	m	+1
+17	1890	m	+1	−6	1884	M	+1
+15	1915	M	−1	−6	1903	m	+2
+15	1885	M	+2	−5	1892	M	+1
+15	1886	M	+3	−5	1887	m	−2
+12	1889	m	0	−5	1898	m	−3
+11	1901	m	0	+4	1908	M	+3
+11	1902	m	+1	−4	1899	m	−2
+11	1909	M	+4	+3	1896	M	+3
+11	1911	m	−2	−3	1900	m	−1
−11	1889	m	−1	−2	1907	M	+2
−11	1893	m	0	+1	1891	m	+2
−10	1805	M	+2	0	1910	m	−3

TABLE 4.—*Deviation of annual rainfall in western Japan from normal, in relation to the epoch of maxima and minima of annual sun-spot numbers.*

	Absolute values of deviations.					
	0–4	5–9	10–14	≧15	0–10	≧11
Number of cases in which those deviations occurred in the years of sun-spot maxima or minima, or 1 year before or after it	1	5	5	6	6	11
The number of the other cases	6	4	3	2	11	4

TABLE 5.—*Period of annual maximum typhoon frequency.*

Year.	Maximum values of typhoon frequency.	Time of maximum typhoon frequency.		Smoothed time maximum typhoon frequency.	
		Month.	*Decade.*	*Month.*	*Decade.*
1897	1.0	October	First	....	....
1898	1.0	September	Second	September	1.8
1899	1.6	August	Second	August	3.3
1900	1.6	July	Third	September	1.5
1901	1.3	October	Second	September	3.5
1902	1.6	September	Second	September	3.6
1903	2.0	{September {October	Third First	}September	2.6
1904	1.3	August	Second–third	September	1.9
1905	1.6	September	Third	September	2.4
1906	2.7	September	Second	September	2.0
1907	1.6	August	Second	September	1.3
1908	2.0	September	Third	September	3.0
1909	1.6	October	Second	October	1.5
1910	1.3	September	Third	September	2.8
1911	2.0	{September {October	Third First	}September	3.8
1912	1.6	September	Third	September	3.1
1913	2.3	September	First	September	1.6
1914	1.6	August	Second–third	August	3.8
1915	2.3	September	First	September	1.6
1916	1.6	September	Third	September	3.4
1917	1.0	October	First–second	....	....

TABLE 6.—*Annual frequency of Yang-tze-kiang cyclones.*

Year.	1904	1905 (M)	1906	1907	1908	1909	1910	1911	1912	1913 (*m*)	1914	1915	1916	1917 (M)
Number of cyclones	15	15	8	13	9	7	7	9	4	9	10	13	10	11

CUMULUS CLOUDS OF HAWAII.

By ANDREW M. HAMRICK, Meteorologist.

[Dated: Cheyenne, Wyo., June 23, 1918.]

The cumulus clouds of Hawaii, especially those which pile up over the Koolau Mountains on the Island of Oahu, are so remarkable in their method of formation that a brief description of them may be interesting in connection with the Bureau's renewed activities in the observation of clouds and upper-air conditions.

They are not convection-formed clouds in the sense of warm air rising and expanding to maintain atmospheric equilibrium, but are the result of the moist air being *forced* upward by the prevailing Northeast Trades as they strike against the steep sides of the Koolau Mountain range. This range extends throughout the length of the Island of Oahu, and lies at right angles to the direction of the Trade winds; therefore the only course of the latter is up, and over.

As the Trade winds prevail throughout the year, the huge cloud-cap may be observed both night and day, summer and winter, except occasionally when overpowered by the "Kona" storms. The height and extent of the clouds usually depend upon the strength of the wind.

References have been made by meteorologists to the fact that cumulus clouds are often convection-formed